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The Relationship of Age and Other Baseline Factors to Outcome of Initial Surgery for Intermittent Exotropia

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Abstract

Purpose: To determine whether age at surgery is associated with surgical outcome of intermittent exotropia (IXT) at 3 years.

Design: Secondary analysis of pooled data from a randomized trial

Methods: 197 children 3 to <11 years of age with basic-type IXT of 15 to 40 prism diopters(Δ) were randomly assigned to one of two surgical procedures for treatment of intermittent exotropia. Masked examinations were conducted every 6 months for 3 years. The primary outcome was suboptimal surgical outcome by 3 years, defined as: constant or intermittent exotropia of ≥10Δ at distance or near by simultaneous prism and cover test (SPCT); constant esotropia of ≥6Δ at distance or near by SPCT; or decrease in near stereoacuity of ≥2 octaves, at any masked examination; or reoperation without meeting any of these criteria.

Results: The cumulative probability of a suboptimal surgical outcome by 3 years was 28% (19 of 72) for children 3 to <5 years of age, compared with 50% (57 of 125) for children 5 to <11 years of age (adjusted hazard ratio = 2.05; 95% CI = 1.16 to 3.60). No statistically significant associations were found between suboptimal outcome and other baseline factors (magnitude of deviation, control score, fixation preference, or near stereoacuity) (P values ≥ 0.20).

[*]A complete list of participating members of the Pediatric Eye Disease Investigator Group (PEDIG) can be found in a previous publication. (Pediatric Eye Disease Investigator Group. A randomized trial comparing bilateral lateral rectus recession versus unilateral recess and resect for basic-type intermittent exotropia. *Ophthalmology* 2019;126(2):305–317.)

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Conclusions: This analysis suggests that in children with IXT, younger age at surgery (3 to <5 years) is associated with better surgical outcomes; however, further evidence from a randomized trial comparing immediate with delayed surgery is needed for confirmation.

Trial Registration: NCT01032603 listed on www.clinicaltrials.gov

Table of Contents Statement:

Three-year outcomes for intermittent exotropia strabismus surgery were better for children who underwent surgery at 3 to <5 years of age compared with those children who underwent surgery at 5 to <11 years of age. No other factors such as size of the exodeviation, control of the deviation, or stereoacuity were associated with a better outcome of surgery.

Keywords

Intermittent Exotropia; Pediatric Ophthalmology; Surgery

Categories:

Pediatric Ophthalmology; Strabismus

Introduction

Limited data exist on whether the outcome of patients undergoing surgery for intermittent exotropia (IXT) is related to age at surgery or other clinical factors.[1–3] We conducted a randomized clinical trial of 197 children with basic type IXT and found no significant difference in the probability of a suboptimal outcome by 3 years comparing bilateral lateral rectus muscle recessions (BLR) with unilateral lateral rectus recession and medial rectus resection (R&R) (46% versus 37% (treatment group difference = 9%, 95% CI = 6% to 23%)).[4] We utilized this dataset to assess whether age at surgery and other baseline factors, such as size or control of the exodeviation, were associated with the surgical outcome.

Methods

The current report is a secondary analysis of pooled prospective data from a randomized trial comparing two types of surgery for IXT. The protocol and Health Insurance Portability and Accountability Act (HIPAA)–compliant informed consent forms were approved by the Jaeb Center for Health Research Institutional Review Board (IRB) (11/09/2009) and other participating institutions' IRBs. A parent or guardian of each participant gave written informed consent. The full study protocol is available on the PEDIG website (www.pedig.net, accessed 4/2/2019). The study is listed on www.clinicaltrials.gov (NCT01032603, accessed 4/2/2019).

As reported previously,[1] children 3 to <11 years of age with basic-type IXT (15 to 40 prism diopters (Δ), inclusive) and at least 400 arcsec near stereoacuity (Randot® Preschool Stereotest, Stereo Optical Co., Chicago, IL) were randomly assigned to bilateral lateral rectus muscle recessions (BLR) or unilateral lateral rectus recession with medial rectus resection (R&R). Each participant had no previous strabismus surgery or botulinum toxin

injections. Masked examinations were performed every 6 months for 3 years postoperatively. Suboptimal surgical outcome was defined as the first occurrence of one or more of three clinical criteria: 1) exotropia of ≥10Δ at distance or near by simultaneous prism and cover test (SPCT), 2) constant esotropia of ≥6Δ at distance or near by SPCT, or 3) decrease in near stereoacuity of ≥2 octaves from enrollment, at any masked examination, or performance of a reoperation without meeting clinical criteria. All patients meeting any criterion by 3 years were considered to have met the suboptimal surgical outcome, regardless of whether the patient subsequently improved before 3 years with or without reoperation.

Because the treatment group difference in the primary outcome was not significant,[4] we pooled data from both surgical approaches to assess the possible association of factors with suboptimal surgical outcome by 3 years. Age at surgery was initially evaluated in 4 age groups (3 to <5, 5 to <7, 7 to <9, and 9 to <11 years), which were combined into 2 age groups (3 to <5 years and 5 to <11 years) when a review of the relationship between continuous age and suboptimal surgical outcome suggested a threshold effect. Categorical variables of sex, race, and prior IXT treatment also were evaluated. Fixation preference was assessed at enrollment (no distance tropia, alternates fixation, 1 eye more often exotropic) and by position of eyes under general anesthesia (aligned, both eyes equally exotropic, one eye more exotropic). Magnitude of deviation by prism and alternate cover test (PACT) at distance and near, and size of surgical angle (largest of PACT measurements at distance, near, and remote distance) were evaluated as continuous and categorical factors. Distance and near control of exodeviation were evaluated using the IXT Office Control Score[5] as a continuous outcome and by dichotomizing according to whether a spontaneous tropia was present (0 to 2 vs. 3 to 5 points). Intermittency versus constancy of the distance exodeviation was assessed throughout the entire exam (as opposed to only during control testing). Stereoacuity, assessed at distance (Distance Randot™ Stereotest[6,7]) and near (Randot® Preschool Stereoacuity Test[8]; Stereo Optical, Chicago, IL), were evaluated by comparing surgical outcomes for each stereoacuity level; near stereoacuity was also combined into subgroups for analysis (40 to 60, 100 to 200, 400). Binocular fixation status (bifoveal, monofixation, or uncertain) at a given distance was assessed using age-specific definitions for both distance[9] and near[8] stereoacuity (Table 1).

For each level of each baseline factor, the cumulative proportion of participants meeting criteria for suboptimal surgical outcome by 3 years was obtained using the Kaplan-Meier (K-M) method. For each baseline factor, hazard ratios and 95% confidence intervals (CI) for suboptimal surgical outcome by 3 years were calculated using Cox proportional hazards regression models. For continuous baseline factors, hazard ratios and 95% CIs for the risk per additional unit were calculated in additional Cox regression models . As the study was a randomized trial, all “unadjusted” proportional hazards regression models included treatment group. The final models were adjusted for the following baseline factors: treatment group, age, distance control, distance alignment by PACT, alignment at distance and near by SPCT, and stereoacuity at near. In addition, an interaction term was added to the adjusted models to assess whether the hazard ratios for suboptimal surgical outcome differed according to surgical group. For any baseline factor found to be associated with suboptimal surgical outcome by 3 years, we explored whether the factor was also related to the risk of reoperation by 3 years by comparing the K-M curves using the log rank test.

All analyses were conducted using SAS version 9.4 (SAS Institute Inc. Cary, NC).

Results

The mean age at surgery was 6.2 years, 62% (122 of 197) were female, and 57% (113 of 197) were white (Table 2).

The cumulative probability of having a suboptimal surgical outcome by 3 years postoperatively was 28% in children 3 to <5 years of age (N=72), 50% in children 5 to <7 years of age (N=59), 50% in children 7 to <9 years of age (N=40), and 49% in children 9 to <11 years of age (N=26). The most common criterion for first occurrence of suboptimal surgical outcome was constant or intermittent XT >=10 Δ either alone {14 of 19 (74%) in 3 to <5 years of age and 36 of 57 (63%) in 5 to <11 years of age} or in combination with stereoacuity loss {0 of 19 (0%) in 3 to <5 years of age and 1 of 57 (2%) in 5 to <11 years of age group} (Table 3). Dividing the cohort into two age groups, the cumulative probability of a suboptimal surgical outcome by 3 years postoperatively was 28% (19 of 72) for children 3 to <5 years of age compared with 50% (57 of 125) for children 5 to <11 years of age (adjusted hazard ratio = 2.05; 95% CI = 1.16 to 3.60) (Tables 3 and 4). There was no evidence that the higher risk in older children differed by type of surgery (adjusted P value for interaction = 0.50). The cumulative probability of reoperation by 3 years postoperatively was 1% (1 of 72) for children 3 to <5 years of age compared with 11% (12 of 125) for children 5 to <11 years of age (P value from log rank test = 0.03). Loss to follow up was similar in both age groups; three years of follow up was completed by 81% (58 of 72) of children 3 to <5 years of age and by 84% (105 of 125) of children 5 to <11 years of age.

Other than age at surgery, no statistically significant associations were found between suboptimal outcome and other baseline factors, including magnitude of angle (at distance or near by PACT), control score (at distance or near), fixation preference (preferred eye vs alternates fixation), and near stereoacuity (by level of Randot® Preschool or by bifoveal vs monofixational) (all adjusted model P values ≥ 0.20), (Table 5).

Discussion

Children 5 to <11 years of age at the time of surgery for IXT were about twice as likely to experience suboptimal surgical outcomes by 3 years after surgery than children 3 to <5 years of age at the time of their surgery. We are not aware of any other prospective data addressing a potential age effect. Our finding is consistent with some retrospective reports. Pratt-Johnson and colleagues[1] found in a study of 100 patients that surgery on children younger than 4 years of age at surgery was more successful than surgery on children over 4 years of age. Abroms and colleagues[2,3] studied 76 patients with constant (N=31) or intermittent IXT (N=45), and found that children younger than 7 years at surgery had better stereo outcomes after an average follow-up of 5.9 years compared with patients age 7 years to adult at surgery. In contrast, a retrospective report by Ing and colleagues[2] found age at initial surgery to not be predictive of success.

Our finding of an age effect on the surgical outcome has limitations. Children 3 to <5 years of age are at lower risk of being misclassified as meeting the stereoacuity suboptimal

outcome criterion solely due to measurement error, given that their underlying stereoacuity and testing ability is improving more rapidly with maturation than in older children. Although the older and younger age at surgery groups appeared reasonably similar on most baseline characteristics, a larger proportion of younger children had “uncertain” baseline binocular fixation status, making it uncertain whether the younger and older age groups were comparable on this baseline variable. In addition, the apparent age effect could be due to unknown or unmeasured factors (e.g., duration of IXT or presence and severity of suppression, which might be related to age or duration), which may have differed between age groups and might be related to surgical outcome. For example, if older participants had a later age of IXT onset than younger participants, the exotropia experienced by older patients may differ from that experienced by younger patients. Furthermore, because the decision to reoperate after a participant met suboptimal surgical outcome was at investigator discretion, there may be bias (such as increased social concerns in older children) in why 11% of older participants underwent reoperation compared with only 1% of younger participants. Based on a recent report, the use of a single surgical dose table may have systematically undercorrected the older children.[10]

There are also limitations to our finding that factors other than age were not associated with an effect on the surgical outcome. The small sample size for levels of some baseline factors may have contributed to not finding any predictive factors other than age. In addition, only children with basic-type IXT of 15 to 40Δ were included so the results cannot be generalized to other types of IXT or larger deviations. The analyses performed in the current report were not the primary pre-planned analysis of the original randomized clinical trial, and as such must be viewed with caution. Future studies are needed to confirm these findings.

In summary, we found 3-year outcomes were better for children with IXT who underwent surgery at 3 to <5 years of age compared with surgery at 5 to <11 years of age. We did not identify other baseline factors associated with this outcome. Our analysis does not address the important clinical question of whether early versus delayed IXT surgery is associated with a better outcome. A clinical trial to address this question would require a study randomly assigning young children of a pre-specified age range to immediate versus deferred surgery.

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Highlights

- Among children 5 to 10 years old, 50% had suboptimal surgical outcome by 3 years.
- Among children 3 to 4 years old, 28% had suboptimal surgical outcome by 3 years.
- Younger age may be associated with better outcomes of intermittent exotropia surgery.

Table 1.

Age-Specific Criteria for Binocular Fixation Status[a]

Age Group (Years)	Bifoveal Fixation (Normal)(arcsec)	Uncertain (arcsec)	Monofixation (Abnormal) (arcsec)
Distance Stereoacuity			
3	60	100 to 400	Nil
4, 5	60	100 to 200	400 to Nil
6 to <13	60	100	200 to Nil
Near Stereoacuity by Preschool Randot Test			
3	40 to 60	100 to 400	800 to Nil
4, 5	40 to 60	100 to 200	400 to Nil
6	40 to 60	100	200 to Nil
7 to <13	40 to 60	--------	100 to Nil

[a]Classification is based on age-norms for the Randot stereoacuity test at distance[9] and near.[8]

Table 2:

Baseline Demographic and Clinical Characteristics Overall and According to Age (N=197)

			Age at Surgery			
	All Participants (N=197)		3-<5 Years (N=72)		5-<11 Years (N=125)	
	N	(%)	N	(%)	N	(%)
FEMALE	122	62	47	65	75	60
RACE/ETHNICITY						
White	113	57	38	53	75	60
African American	27	14	12	17	15	12
Hispanic	44	22	19	26	25	20
Other	13	7	3	4	10	8
AGE AT SURGERY						
3 to<5 years	72	37	72	100	----	----
5 to <7 years	59	30	----	----	59	47
7 to <9 years	40	20	----	----	40	32
9 to <11 years	26	13	----	----	26	21
Mean (SD)	6.2 (2.0)		4.1 (0.6)		7.3 (1.6)	
Range	3.0 to <11.0		3 to <5		5 to <11	
PRIOR TREATMENT	99	50	42	58	57	46
TREATMENT GROUP						
Bilateral lateral rectus recession	101	51	33	46	68	54
Unilateral lateral rectus recession and medial rectus resection	96	49	39	54	57	46
DEVIATING EYE AT ENROLLMENT						
No distance tropia[a]	30	15	11	15	19	15
Alternates	83	42	31	43	52	42
One eye more exotropic	84	43	30	42	54	43
POSITION OF EYES UNDER DEEP ANESTHESIA						
Not assessed[b]	19	10	10	14	9	7
Aligned	25	13	10	14	15	12
Both eyes equally exotropic	76	39	28	39	48	39
One eye more exotropic	73	37	23	32	50	40
More exotropic eye operated	39	53	13	57	26	52
Less exotropic eye operated	5	7	2	9	3	6
Both eyes operated	29	40	8	35	21	42
Other	3	2	1	1	2	2
BINOCULAR FIXATION STATUS AT NEAR[c]						

			Age at Surgery			
	All Participants (N=197)		3-<5 Years (N=72)		5-<11 Years (N=125)	
	N	(%)	N	(%)	N	(%)
Bifoveal	73	37	12	17	61	49
Uncertain	69	35	48	67	21	17
Monofixation	55	28	12	17	43	34
BINOCULAR FIXATION STATUS AT DISTANCE[c]						
Bifoveal	52	27	12	18	40	32
Uncertain	57	30	29	43	28	22
Monofixation	83	43	26	39	57	46
STEREOACUITY AT DISTANCE(arcsec)						
60	52	27	12	18	40	32
100 to 200	67	35	23	34	44	35
400 to nil	73	38	32	38	41	33
Median (25^{th} pcnt, 75^{th} pcnt)	2.3 (1.8, 2.6)		2.3 (2.0, 2.6)		2.0 (1.8, 2.6)	
Range	1.8 to 2.9		1.8 to 2.9		1.8 to 2.9	
STEREOACUITY AT NEAR (arcsec)						
40 to 60	73	37	12	17	61	49
100 to 200	84	43	35	49	49	39
400	40	20	25	35	15	12
Median (25^{th} pcnt, 75^{th} pcnt)	2.0 (1.8, 2.3)		2.3 (2.0, 2.6)		2.0 (1.8, 2.0)	
Range	1.6 to 2.6		1.6 to 2.6		1.6 to 2.6	
EXODEVIATION STATUS AT DISTANCE						
Constant exotropia[d]	45	23	20	28	25	20
Intermittent exotropia	152	77	52	72	100	80
EXODEVIATION STATUS AT NEAR						
Intermittent exotropia	174	88	66	92	108	86
Exophoria	23	12	6	8	17	14
BASELINE EXOTROPIA CONTROL AT DISTANCE[e]						
0 to 2 (no spontaneous tropia)	54	27	17	24		30
3 to 5 (spontaneous tropia)	143	73	55	76	88	70
Mean (SD)	3.4 (1.3)		3.6 (1.3)		3.3 to 1.3	
Range	0 to 5		1 to 5		0 to 5	
BASELINE EXOTROPIA CONTROL AT NEAR[d]						
0 to 2 (no spontaneous tropia)	1131	666	47	65	84	67
3 to 5 (spontaneous tropia)	66	34	25	35	41	41
Mean (SD)	1.8 (1.3)		1.9 (1.2)		1.8 (1.3)	

	Age at Surgery					
	All Participants (N=197)		3-<5 Years (N=72)		5-<11 Years (N=125)	
	N	(%)	N	(%)	N	(%)
Range	0 to 5		0 to 4		0 to 5	
BASELINE EXOTROPIA MAGNITUDE BY SPCT AT DISTANCE						
No measurable exotropia[f]	32	17	12	16	20	16
10 to 15 Δ	5	3	2	3	3	2
16 to 19 Δ	25	13	7	10	18	14
20 to 25 Δ	87	44	36	50	51	41
30 to 35 Δ	43	22	13	18	30	24
40 to 50 Δ	5	3	2	3	3	2
Mean (SD)	20 (11)		21 (11)		20 (11)	
Range	0 to 40		0 to 40		0 to 40	
BASELINE EXOTROPIA MAGNITUDE BY SPCT AT NEAR						
No measurable exotropia[f]	109	56	41	57	68	54
1–9 Δ	4	2	1	1	3	2
10–15 Δ	8	4	2	3	6	5
16–19 Δ	16	8	7	10	9	7
20 to 25 Δ	32	16	13	18	19	15
30 to 35 Δ	27	14	8	11	19	15
40 to 50 Δ	1	<1	0	0	1	<1
Mean (SD)	10 (13)		10 (12)		11 (13)	
Range	0 to 40		0 to 35		0 to 40	
BASELINE EXOTROPIA MAGNITUDE BY PACT AT DISTANCE						
10–14 Δ	----	----				
15–18 Δ	19	10	6	8	13	10
20–25 Δ	105	53	39	54	66	53
30–35 Δ	67	34	25	35	42	34
40 Δ	6	3	2	3	4	3
Mean (SD)	26 (6)		27 (5)		26 (6)	
Range	16 to 40		16 to 40		16 to 40	
BASELINE EXOTROPIA MAGNITUDE BY PACT AT NEAR						
10–14 Δ	22	11	4	6	18	14
15–18 Δ	31	16	12	17	19	15
20–25 Δ	71	36	30	42	41	33
30–35 Δ	65	33	23	32	42	34
40 Δ	8	4	3	4	5	4
Mean (SD)	24 (8)		25 (7)		24 (8)	
Range	10 to 40		10 to 40		10 to 40	

--- indicates not applicable

Δ – Prism diopters; PACT – Prism and Alternate Cover Test; pcnt – percentile; SD = standard deviation

[a] Note that these patients did not have distance tropia by cover/uncover test but their assessment of distance deviation over the exam was "intermittent XT." The way the data form was written, the questions about which eye deviates were not required to be answered when there was no distance tropia on cover/uncover testing.

[b] 19 patients (10 in the 3 to <5-years-old group and 9 in 5 to <11 years old group) did not have eye position evaluated under deep anesthesia, and one patient in 5 to <11 years old group did not undergo surgery.

[c] Classification to bifoveal or monofixation status was based on age-normal values for the Randot stereoacuity test at distance[9] and near.[8]

[d] Constant refers to constant exotropia throughout the exam at distance.

[e] Classification of the exodeviation was assessed at distance (6 m) and at near (1/3 m) using the Office Control Score [5] on a scale from 0 (exophoria or orthodeviation) to 5 (constant exotropia).

[f] No measurable exotropia' includes participants who met any of the following: 1) did not have a tropia during the exam, 2) had an exotropia not detectable by the cover/uncover test, and 3) had an exotropia that was not measurable because it was too brief, too small, or the participant was not cooperative enough to allow a SPCT measurement.

Table 3:

Suboptimal Surgical Outcome According to Age Group by Length of Follow-Up[a]

Length of follow up	6 Months		12 Months		18 Months		24 Months		30 Months		36 Months		Total	
Age at surgery (years)	**3-<5**	**5-<11**	**3-<5**	**5-<11**	**3-<5**	**5-<11**	**3-<5**	**5-<11**	**3-<5**	**5-<11**	**3-<5**	**5-<11**	**3-<5**	**5-<11**
N at risk	71	118	60	86	54	73	53	62	46	59	43	55	---	---
N with suboptimal surgical outcome	10	29	1	10	1	11	5	1		4	2	2	19	57
N with clinical criterion														
Constant or intermittent XT >=10Δ only[b]	6	15	1	7	1	8	4	1		3	2	2	14	36
Constant ET >=6Δ only[c]		2		1										3
Stereo worsening[d]	3	5				3	1			1			4	9
Stereo worsening[d] ***and XT >=10Δ***[b]		1												1
Stereo worsening[d] ***and constant ET>=6Δ***[b]		5		2										7
N reoperated without clinical criterion	*1*	*1*											*1*	*1*
Cumulative % with suboptimal surgical outcome	14%	25%	16%	33%	17%	43%	25%	44%	25%	48%	28%	50%	28%	50%

ET = esotropia; Δ = prism diopters; XT = exotropia; SPCT = Simultaneous Prism and Cover Test;

[a]Suboptimal surgical outcome was defined as the first occurrence of one or more of the three clinical criteria (constant or intermittent XT >=10 Δ only,[b] constant ET >=6 Δ only,[c] stereo worsening[d]) or reoperation without meeting clinical criteria.

[b]Exotropia ≥10 Δ by SPCT at distance or near, confirmed by a retest.

[c]Constant esotropia ≥6 Δ by SPCT at distance or near, confirmed by a retest.

[d]Decrease in Randot Preschool near stereoacuity ≥2 octaves (≥0.6 log arcsec) from enrollment, or to nil, confirmed by a retest.

Table 4:

Suboptimal Surgical Outcomes by 3 Years According to Age (2 Group)

	Age at Surgery		Hazard Ratio for Meeting Suboptimal Surgical Outcome for 5-<11 Years Old vs. 3 to <5 Years Old at Surgery (95% CI)	
	3 to <5 years (N=72)	5 to <11 years (N=125)	Unadjusted[a]	Adjusted[b]
Cumulative probability of meeting suboptimal surgical outcome	19 (28%) (19% to 41%)	57 (50%) (41% to 59%)	2.00 (1.19 to 3.37)	2.05 (1.16 to 3.60)

XT = exotropia

[a]Hazard ratio adjusted for treatment group only.

[b]Hazard ratio adjusted for the following baseline factors: treatment group, distance control, angle magnitude by Prism and Alternate Cover Test (PACT) at distance and by Simultaneous Prism and Cover Test (SPCT) at distance and near, and stereoacuity at near in log arc seconds

Table 5:

Suboptimal Surgical Outcome by 3 Years According to Baseline Characteristics

	N	Suboptimal Surgical Outcome by 3 Years N (Cumulative Probability)	Unadjusted Hazard Ratio (95% CI)[a]	Adjusted Hazard Ratio (95% CI)[b]
SEX				
Female	122	51 (45%)	1.29 (0.80 to 2.08)	1.30 (0.80 to 2.12)
Male	75	25 (36%)	1.00	1.00
RACE/ETHNICITY				
White	113	44 (42%)	1.00	1.00
African American	27	11 (44%)	1.04 (0.54 to 2.02)	1.12 (0.57 to 2.17)
Hispanic	44	14 (33%)	0.75 (0.41 to 1.37)	0.90 (0.48 to 1.68)
Other	13	7 (58%)	-------	-----
PRIOR NON-SURGICAL TREATMENT				
Yes	99	34 (36%)	0.73 (0.46 to 1.14)	0.77 (0.48 to 1.22)
No	98	42 (48%)	1.00	1.00
DEVIATING EYE AT ENROLLMENT				
No distance tropia[c]	30	(31%)	0.63 (0.30 to 1.31)	0.99 (0.18 to 5.43
Alternates fixation	83	(44%)	1.00	1.0
One eye more exotropic[d]	84	(44%)	1.01 (0.63 to 1.64)	0.97 (0.59 to 1.60)
POSITION OF EYES UNDER DEEP ANESTHESIA				
Aligned	25	8 (33%)	0.69 (0.32 to 1.50)	0.70 (0.32 to 1.54)
Both eyes equally exotropic	76	30 (42%)	0.88 (0.53 to 1.48)	0.90 (0.53 to 1.51)
One eye more exotropic	73	31 (47%	1.00	1.00
STEREOACUITY AT DISTANCE (arcsec)				
Risk per additional log arcsec		-----	1.32 (0.78 to 2.24)	1.50 (0.82 to 2.76)
60	52	17 (35%)		
100	33	17 (56%)		
200	34	12 (38%)		
400	33	10 (34%)		
Nil	40	20 (54%)		
60	52	17 (35%)	1.00	1.00
100 to 200	67	29 (47%)	1.58 (0.87 to 2.88)	1.65 (0.89 to 3.05)
400 to nil	73	30 (45%)	1.46 (0.81 to 2.65)	1.73 (0.86 to 3.46)
STEREOACUITY AT NEAR (arcsec)				
Risk per additional log arcsec		-----	0.79 (0.41 to 1.53)	0.91 (0.44 to 1.89)
40	31	14 (48%)		
60	42	15 (38%)		

	N	Suboptimal Surgical Outcome by 3 Years N (Cumulative Probability)	Unadjusted Hazard Ratio (95% CI)[a]	Adjusted Hazard Ratio (95% CI)[b]
100	59	26 (48%)		
200	25	6 (25%)		
400	40	15 (41%)		
40 to 60	73	29 (42%)	1.00	1.00
100 to 200	84	32 (41%)	1.02 (0.62 to 1.68)	1.13 (0.67 to 1.91)
400	40	15 (41%)	0.94 (0.50 to 1.76)	1.08 (0.54 to 2.13)
FIXATION STATUS AT DISTANCE[e]				
Bifoveal	52	17 (35%)	1.00	1.00
Uncertain	57	24 (45%)	1.48 (0.80 to 2.80)	1.71 (0.89 to 3.29)
Monofixation	83	35 (47%)	1.54 (0.86 to 2.76)	1.64 (0.87 to 3.11)
FIXATION STATUS AT NEAR[e]				
Bifoveal	73	29 (42%)	1.00	1.00
Uncertain	69	23 (36%)	0.85 (0.49 to 1.47)	1.38 (0.63 to 3.03)
Monofixation	55	25 (49%)	1.19 (0.69 to 2.04)	1.57 (0.64 to 3.87)
CONTROL AT DISTANCE[f]				
Risk per additional point	-----	-----	1.04 (0.87 to 1.24)	1.01 (0.83 to 1.22)
0 (exophoria or orthodeviation)	1	1 (100%)		
1	15	3 (24%)		
2	38	18 (51%)		
3	42	14 (38%)		
4	49	16 (35%)		
5	52	24 (48%)		
0–2 (no spontaneous tropia)	54	22 (45%)	1.00	1.00
3–5 (spontaneous tropia)	143	54 (41%)	0.87 (0.53 to 1.44)	0.86 (0.51 to 1.44)
CONTROL AT NEAR[f]				
Risk per additional point	-----	-----	0.93 (0.78 to 1.11)	0.88 (0.70 to 1.09)
0 (exophoria or orthodeviation)	30	13 (46%)		
1	63	25 (43%)		
2	38	15 (44%)		
3	42	14 (37%)		
4	23	9 (41%)		
5 (constant exotropia)	1	0 (0%)		
0–2 (no spontaneous tropia)	131	53 (44%)	1.00	1.00
3–5 (spontaneous tropia)	66	23 (37%)	0.83 (0.51 to 1.36)	0.76 (0.44 to 1.34)
PACT AT DISTANCE				
Risk per additional Δ	-----	-----	0.99 (0.95 to 1.02)	0.98 (0.94 to 1.02)
16 to 20	66	28 (47%)	1.00	1.00

	N	Suboptimal Surgical Outcome by 3 Years N (Cumulative Probability)	Unadjusted Hazard Ratio (95% CI)[a]	Adjusted Hazard Ratio (95% CI)[b]
25 to 30	97	35 (39%)	0.79 (0.48 to 1.30)	0.75 (0.44 to 1.29)
35 to 40	34	13 (40%)	0.80 (0.41 to 1.54)	0.70 (0.33 to 1.49)
PACT AT NEAR				
Risk per additional Δ	-----	-----	0.99 (0.96 to 1.02)	0.99 (0.93 to 1.04)
10 to 20	87	37 (46%)	1.00	1.00
25 to 30	77	23 (33%)	0.62 (0.37 to 1.04)	0.67 (0.34 to 1.34)
35 to 40	33	16 (50%)	1.06 (0.59 to 1.91)	1.14 (0.41 to 3.20)
PACT SURGICAL ANGLE[g]				
Risk per additional Δ	-----	-----	0.99 (0.95 to 1.02)	0.98 (0.94 to 1.02)
16 to 20	49	19 (41%)	1.00	1.00
25 to 30	98	37 (42%)	0.93 (0.53 to 1.61)	1.26 (0.61 to 2.59)
35 to 40	50	20 (41%)	0.91 (0.49 to 1.70)	1.44 (0.46 to 4.50)
TREATMENT GROUP				
Bilateral lateral rectus recession	101	43 (46%)	1.28 (0.81 to 2.01)	1.22 (0.77 to 1.94)
Unilateral lateral rectus resection and medial rectus resection	96	33 (37%)	1.00	1.00
EXOTROPIA STATUS AT DISTANCE				
Constant	45	22 (51%)	1.42 (0.86 to 2.33)	1.41 (0.80 to 2.48)
Intermittent	152	54 (39%)	1.00	1.00

PACT = prism and alternate cover test; Δ = prism diopters; SPCT = Simultaneous prism and cover test

----- hazard ratios were not estimated for subgroups with N < 20

[a]Unadjusted hazard ratios from proportional hazards models adjusting for treatment group.

[b]Adjusted hazard ratios from proportional hazards models adjusting for the treatment group, continuous age, distance control, angle magnitude by PACT at distance and by SPCT at distance and near, and stereoacuity at near in log arc seconds.

[c]Note that these participants did not have distance tropia by cover/uncover test but their assessment of distance deviation over the exam was "intermittent XT." The way the data form was written, the questions about which eye deviates were not required to be answered when there was no distance tropia on cover/uncover testing.

[d]A breakdown of whether the operated eye was more exotropic or less exotropic than the other eye was provided only for participants who had one eye more exotropic than the other.

[e]Classifications of bifoveal fixation and monofixation were based on age-normal values using Randot stereoacuity at distance[9] and near[8] (see Table 1).

[f]Classification of the exodeviation was assessed at distance (6m) and at near (1/3 m) using the Office Control Score[5] on a scale from 0 (exophoria or orthodeviation) to 5 (constant exotropia).

[g]Angle operated is the largest of PACT at distance, near, and remote distance. The largest PACT was at distance for 58% of participants, near for 6%, and remote distance for 37%.